Provisional chapter

Organic livestock Farming — Challenges, Perspectives, and Strategies to Increase Its Contribution to the Agrifood System's Sustainability — A Review

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Abstract

The livestock sector is of great importance for the sustainability of rural economies and many ecosystems; however, it also has a high environmental impact. Due to the growing demand for animal products, there is a need to design new livestock production systems that allow the combination of food security and sustainability. Within this context, organic livestock may be a useful strategy to achieve such a pivotal goal. However, there is a lack of studies that integrate the existing knowledge, specifically in organic livestock, and integrating the main aspects implied in its practice (its externalities and challenges). The present work aims to fill this knowledge gap, providing strategies and insights that will help stakeholders and policy makers to improve the sustainability of both the organic sector itself and that of the whole food system.

Keywords: Organic, cattle, livestock, sustainability, food system

1. Introduction

There has been considerable growth in the number of organic livestock farms [1] in response to the necessity to fulfill the growing demand for animal products predicted for 2050 [2]. Furthermore, it is required to combine it with the farms' profitability, environmental protection, food safety, and ethical concerns. Due to this, organic livestock farms are nowadays not a despicable part of the census. However, there is no consensus about the consequences of organic livestock farming systems to the sustainability of the overall food system. This lack of convergence has its roots in the effect played by the different characteristics and contexts of the farms. Moreover, some barriers are challenging the development of the sector and shaping its future perspectives. Within this context, and in view of the lack of studies addressing the sustainability of the organic livestock sector as a whole by integrating different points of view, it is very timely to conduct a thorough study of this type. Due to this, the present review was carried out, aimed at improving the knowledge about the organic livestock sector such that it will be possible to adopt a holistic view that increases our understanding of its challenges and future perspectives, with a special emphasis on the sustainability of both farms and the whole food system. This integrative knowledge and approach will help stakeholders and policy makers to make decisions, either at the farm level (implement organic farms) or making policies. Thus, they both will be able to design strategies that increase the sustainability, competitiveness, and success of organic livestock farms, looking at the sustainability of the food systems as a final and priority goal.

1.1. Socio-economic and environmental role of livestock production

Animal production systems are of great importance for the sustainability of rural economies and many ecosystems. The economic importance of livestock activity is reflected by the weight of the agricultural sector in the regional gross domestic product. For example, in rural areas located in southern Europe, cattle, swine, and small ruminants sectors billed 396.46 M € in 2010, representing 36.10% of the agricultural sector production in some regions [3].

From the social point of view, it is noteworthy that in semi-arid regions, such those in the Mediterranean basin, the extensive livestock production systems are often the main activity, and even the only source of livelihood. This dependence of the sector highlights the need to protect and enhance it, as it contributes to the creation of jobs, to the rural economy, and to the fixation of the rural population, which are vital for sustainable development in rural areas worldwide [4-5].

From a cultural perspective, the particularities of the different livestock systems are crucial for the conservation of the heritage, including breeds, landscapes, and habitats of high aesthetic and environmental value [6-7], which redounds in the economic development of the rural areas.

Regarding the environment, livestock activity involves lots of environmental benefits [8], especially when it is carried out under environmentally-friendly production systems, such as the extensive, pasture-based, low-input, and/or organic systems.

However, the livestock sector also has an important environmental impact. This sector employs 30% of the overall area not covered by ice and uses around 80% of global agricultural land. It also generates most of the greenhouse gas (GHGs) emissions in the agricultural sector, accounting for 14.5% of human-induced GHGs, exceeding that from transportation [9].

Moreover, it is a major consumer and polluting water resources, contributing around 30% of N and P content of watercourses [10-13]. These data are even more striking in the case of the bovine meat sector as beef is often the food of animal origin with greater ecological impact [14-18]. Moreover, various socio-economic factors have led to either the abandonment or the intensification of the farms, which threatens the conservation of valuable agro-ecosystems.

Such environmental impact, along with the increasing demand toward animal products, makes it difficult to combine profitability, competitiveness, and environmental sustainability. Consequently, it is necessary to design and implement sustainable livestock systems globally (environmentally, socially, and economically), in which organic ones have an important role to play.

2. Objectives

The objectives of the present work is (i) to fill the existing knowledge gap with regard to the sustainability, challenges, and perspectives of the organic livestock sector, as well as regarding its contribution to the agrifood system's sustainability. Moreover, this study is also aimed at (ii) providing strategies and insights that will help stakeholders and policy makers to improve the sustainability of both the organic livestock sector and that of the whole food system.

3. Externalities of organic livestock farming systems

To reduce the abovementioned environmental impacts, different production systems have been developed. Among them, organic livestock farms have been studied by several authors in order to assess their potential and impact on environmental [19-22] and socio-economic aspects (sustainable rural development) [23-24].

However, some results are contradictory and some papers are not conclusive, which make it difficult to generalize the advantages of the organic livestock sector at either farm level or globally. This lack of convergence in the results is due to the fact that the externalities of organic livestock farms are highly dependent on their structure, the breeds reared, as well as their management, context, and marketing strategies [23-25]. In other words, it seems that there is no one-size-fits-all solution. Moreover, papers normally address specific aspects of the farms (i.e., economic, health, welfare, etc.), which does not allow an integrative picture of the situation.

In order to deal with this scenario, many points must be addressed, as [26] argued, "the concept of organic animal farming can only fulfill the criteria for sustainability if all requirements on animal health, welfare, and ecological soundness are strongly considered and controlled". Due to this, an analysis of the aspects mentioned by these authors, along with those related to the economic and social aspects, have been included in the present work.

3.1. Social dimension: Sustainable rural economy and development

An important part of the world forms part of the so-called "rural areas". In the case of the European Union, rural areas cover 90% of its territory, where over 23% of the European population lives in them, and another 35% lives in intermediate zones. In these areas, farming is one of the main drivers of sustainable rural development [27].

However, these areas are going through processes of depopulation that reduces the sustainability of such areas, from the social, economic, and environmental points of view. Due to this, there is a necessity to develop strategies that allow overcoming this issue. Within these strategies, organic farming has become popular, even in the legislative environment. In fact, [28] defines organic production as "a system of farm management and food production that plays a dual societal role: on the one hand it provides food products to meet specific consumer demands; on the other hand it delivers public goods that contribute to the protection of the environment and animal welfare, as well as to the development of rural areas".

As a consequence, several researchers have evaluated the contribution of organic livestock to sustainable rural development [29-30], of which most of them have been reviewed and discussed by [24]. Some of them have considered that organic production is an important pillar of sustainable rural development, since this production model generates more positive externalities than the conventional one in terms of conservation of agro-ecosystems, creation of jobs, farms' profitability, workers´ income, and local economy.

In this regard, it is fair to mention that most of the benefits provided by the organic production model in relation to rural development seem to be due to both their participation in short marketing channels [31-32] and obtaining a higher price ("price premium") for their organic products [33-34]. According to the authors cited, this premium price is necessary for organic farms profitability, especially during the years of conversion, because the farms' incomes are often reduced and costs increased [31-32]. However, there is controversy on the relationship between the condition of being organic and short marketing channels, but in general terms, such relationship is weak [24, 35].

However, few studies addressed the potential role of organic livestock production systems (studies usually mix agriculture and livestock) towards sustainable development, despite having been proposed to be models of it [30]. Furthermore, such studies show contradictory results and did not adopt a holistic approach (social, economic, and environmentally public policies), which is really needed. Due to this, [24] summarized the studies published with regard to organic livestock sector and discussed them with the results of the case study they carried out addressing organic beef cattle farms located in southwestern Europe.

Studies dealing with this topic paid special attention to the number of jobs created, salaries paid, and the profitability of the farms. Thus, authors such as [36] found no increased presence of labor in organic livestock farms when compared with conventional holdings. On the contrary, [24] found that organic beef cattle farms (mainly those that also fattened their calves) used more labor. However, these last authors stated that this was mainly due to both the higher degree of business diversification of these farms and the fact that for many of the farmers, the farm under study was not the only source of income. Both aspects increased the necessity to hire external workforce. Moreover, [24] found that the salaries paid by the organic farms were lower than those of the conventional ones, which is contrary to the findings of the review carried out by [23]. However, these two last studies did not focus only livestock farms, such that results cannot be compared precisely.

[37] concluded that organic dairy farms may contribute more to the local economy and economic development of rural communities located in the northeast and upper midwest of the U.S. than average and similar-size conventional dairy farms. As they stated, in Vermont, organic dairy farm sales revenue would result in greater state-wide impacts of 3% in output, 39% in labor income, 33% in gross state product, and 46% in employment relative to the impacts from an equivalent level of sales revenue to conventional dairy farms. In Minnesota, these economic impacts are 4, 9, 11, and 12% greater.

Later, [24] found that organic beef cattle farms that fattened their calves performed better from the economic point of view. These authors compared these full-cycle organic farms with (i) conventional farms that scarcely fattened their calves and (ii) organic farms with no fattening period. This comparison allowed them to conclude that the differences were mainly due to the consequences that some differential factors had on overall economic performance, more than the condition of being organic. These factors were the following: most of the farms that fattened their calves were full-cycle (they were part of an association that had the organic crops, the mill, the livestock farms, the trucks, and even established contracts with supermarkets). Moreover, they all received the subsidies for organic farming (in the other organic group of farms they did not), and they sold their fattened calves at a price 25% higher than that of the conventional ones. However, as the production cycle (and the age at which calves were slaughtered) was longer, these farms showed lower economic performances when it was calculated per year.

In summary, the authors have come to the conclusion that many of the benefits provided by organic production in relation to rural development are not due to the mere fact produced under the ecological model, but to sell their products through short marketing channels [31-32] and to obtain a higher price (“price premium”) for organic products [33-34]. This is especially important during the years of conversion because farm incomes are often reduced, and its costs increased.

Moreover, the pathway followed by the products (marketing channels) has a great impact on the sustainability of the food system. Thus, transportation accounted for 17.43% of the total energy consumed by the Spanish food sector in 2000 [38]. In this sense, it is important to comment that short marketing channels (and “local” products) are commonly thought to have lower environmental impacts. However, the concentration of supply can lead to lower emissions of GHGs of short marketing channels, in which small amounts of products are transported by vehicle or fuel. In fact, [38] found that most of that 17.43% of energy consumed by transport comes from road transport due to their lower energy efficiency per load transported.

3.2. Environmental dimension

Pasture-based and low-input livestock systems (e.g., the organic systems) are key to the ecosystems in which they are integrated as they provide with numerous benefits, such as increased carbon sequestration, improved quality of the pastures, and reduction of scrub invasion and risk of fire [5, 8, 39].

According to [28], livestock production is fundamental to the organization of agricultural production on organic holdings in so far as it provides the necessary organic matter and nutrients for cultivated land and accordingly contributes towards soil improvement and the development of sustainable agriculture. [40] completed this view arguing that organic livestock provides organic nutrients that are recycled at the farm level, allowing the production of on-farm inputs, which increases their sustainability. Similarly, [41] claimed that when cattle are introduced in environmental systems, increased efficiency and sustainability occurs. However, organic livestock farms do not always present a significant cultivated area, so that their differences with conventional farms with regard to this parameter may be few [24]. Moreover, mixed crop-livestock farms could miss out on potential economies of scale. To overcome these interactions, organic mixed crop-livestock farms could be a solution, since [42] observed that these farms exploited the diversity of herd feed resources more efficiently than the rest of the groups, which varied in both their degrees of mixing these two components and their organic/conventional status.

In relation to water resources, some authors have found that its use is more efficient in organic farms, and that water retention is increased, leading to higher resistance to drought [43]. Moreover, in these farms, land degradation is prevented and soil fertility increased [44]. These aspects are of particular interest in semi-arid areas, where water shortages often occur, and both soils and pastures are poor. Additionally, it has been shown that agrobiodiversity is greater in organic agro-ecosystems [20, 21, 45], which greatly increases the number of interactions between system components and their complexity. Therefore, their resilience is increased, which is key for their adaptation and resistance against pests, diseases, and climate change. In parallel, their higher degree of business diversification make them less vulnerable in the face of market changes [25, 44].

When looking at comparisons between organic livestock farming systems and conventional ones, several authors have shown that organic systems have a greater potential to preserve the environment, mainly with regard to biodiversity [19-21]. These positive externalities are the consequence of many factors, such as the reduced use of inputs, better nutrient recycling, less use and exploitation of non-renewable/external resources, and finally, ecotoxicity.

These aspects are of great importance, since the increasing degradation of the agricultural soils and the reduction in the supplies of fresh water are two of the most serious problems that humankind is facing. These problems pose an impediment to achieving food security, especially if one takes into account the growing population and demand for animal products. It is even more relevant in developing countries and in semi-arid areas characterized by pasture-based (low-input/pasture-based/extensive) production systems. According to several authors [46-47], organic livestock systems have the potential to contribute to the sustainability of these areas.

Due to the advantages provided by organic livestock production, it would be logical to think that this production model allows facing the two main challenges of the food system: sustainability and food security. In this sense, [48] stated that a shift to organic production will be increasingly necessary for the renewal of resources (mainly water and soil) and to secure sustainable food security. However, there is much debate in this sense [49], due to the lower production that organic production often shows, the increased need for agricultural land for organic production, and the scarcity of organic fertilizers of good quality.

Regarding the environmental impact in terms of GHGs and energy use, extensive and low-input farms (including the organic ones) tend to be more sustainable [50-52]. Among other reasons, this is due to lower consumption of fossil fuels and energy. However, some studies conclude that emissions in organic systems may be higher than those of the conventional ones [16], because they have lower production per unit of input. In this sense, [22] showed that the product carbon footprint in dairy cow organic farms was significantly higher than that of the conventional farms [1.61±0.29 vs. 1.45±0.28kg of CO_2 equivalents (CO_2 eq) per kg of milk].

This divergent results are showing that the differences among studies are mainly due to the productive system under study, its context, the experimental design work, and the units and limits of the study (farm level, hectare, unit of product, food system, etc.), more than their conditions of being organic.

One of the aspects that plays a great effect on greenhouse emissions of the farms is the quality of the feed. In this sense, [53] measured the GHGs from enteric fermentation and manure on organic and conventional dairy farms in Germany in order to assess the effect of different feeding practices. In general terms, lower emissions from enteric fermentation were found when feed quality and feed intake was increased (which normally means feedstuff, instead of pastures). In general terms, results depended strongly on the calculation methodology, especially those related to enteric fermentation. Moreover, differences between the methods were particularly prominent when high amounts of fiber-rich feedstuff were used. As feed quality management on farms influences milk yield and enteric CH_4 emissions, these aspects should be part of advisory concepts that aim at reducing GHG emissions in milk production.

In line with these results, [22] stated that feed demand per kilogram of milk, high grassland yield, and low forage area requirements per cow are the main factors that decrease PCF (product carbon footprints). They observed that the interaction between GHG mitigation and the farm's profitability is key for improving efficiency and sustainability. Thus, for organic farms, a reduction of feed demand of 100 g/kg of milk resulted in a PCF reduction of 105 g of CO_2 eq/kg of milk and an increase in incomes of approximately 2.1 euro cents (c)/kg of milk. For conventional farms, a decrease of feed demand of 100 g/kg of milk corresponded to a reduction in PCF of 117 g of CO_2 eq/kg of milk and an increase in management incomes MI of approximately 3.1 c/kg of milk. Accordingly, farmers could achieve higher profits while reducing GHG emissions.

Regarding the environmental externalities of the different livestock species and sectors, dairy cows are those that have received more attention. [54] studied the productive, environmental and economic performances of organic and conventional suckler cattle farming systems. They found that the reduction in the use of inputs resulted in a 23% to 45% drop in NRE (non-renewable energy) consumption/ha, 5-20% of which is a drop in non-renewable energy per ton of live weight produced. The authors stated that, however, the shift to organic farming does not significantly affect gross GHG emissions per ton of live weight produced, but suggested that net GHG emissions could be lower for organic farming systems due to the carbon sequestration in grasslands. Contrary to the results that are normally found when GHGs are measured per kg of product, the lower productivity per hectare (fewer animals reared per hectares) allowed a reduction from 26% to 34% in net GHG emissions per hectare of farm area in the study of [54].

[55] reviewed studies that compared different beef production systems using life cycle analysis (LCA). They classified such systems by three main characteristics: origin of calves (bred by a dairy cow or a suckler cow), type of production (organic or non-organic), and type of diet fed to fattening calves (roughage-based -<50% concentrates, or concentrate-based -≥50% concentrates). They observed that organic farms had lowers GWP (global warming potential) and use of energy (on average 7% and 30%, respectively) than that of the non-organic systems. However, they showed higher eutrophization potential, acidification potential, and land use per unit of beef produced. Lower GWP (on average 28% lower), energy use (13% lower), and land use (41% lower) were found per unit of beef for concentrate-based systems when compared with roughage-based systems. Although these results are not giving the whole picture (because aspects such as biodiversity, carbon sequestration, and others were not included in all the studies), the authors came to interesting conclusions that we cite literally:

- Environmental impacts were lower for dairy-based than for suckler-based beef
- GWP was similar for organic and non-organic beef
- GWP, energy use, and land use were lower for concentrate- than roughage-based beef
- Dairy-based beef showed the largest potential to mitigate environmental impacts of beef
- Marginal grasslands unsuitable for dairy farming may be used for production of suckler-based beef to contribute to the availability and access to animal-source food

The study of [56] studied the potential environmental impacts of four different types of organic dairy farms, paying special attention on the farm´s structure (the percentage of grassland on total farm area, and feeding intensity). The results showed that farms with high feeding intensity tend to show ecological advantages with regard to their climate impact and their demand for land. On the contrary, low-input farms showed to be better with regard to animal welfare, milk quality, and ammonia losses. But more interestingly, when they assessed the overall environmental index of the farms, low-input and mixed ones showed the best results. Finally, the authors pointed out the necessity of using a wider range of environmental parameters, since results may differ greatly between studies, farms, and systems.

[57] measured the carbon footprint of the organic dairy sector, based on farm data from six European countries. The results showed that the main contributor to the farm´s carbon footprint was enteric fermentation, which has much to do with the feed management, as exposed earlier.

To sum up, high-quality feedstuffs reduce enteric methane emissions, and this is important because these emissions account for a high proportion of total GHGs (45% of them in the study of [57]). However, one must keep in mind that the environmental impact of the farms belongs to just one pillar of global sustainability. Hence, with regard to feed, other factors must be taken into account, such as the competence with human food.

Regarding the methodological aspects of the assessment of farm sustainability, it must be remembered that the different parameters, frameworks, and approaches available, as well as the limit of the study and the context of the farms, make it difficult to integrate results and make conclusions. In this sense, [57] stated that the method for calculating the carbon footprint could be improved, since this calculation does not take account of carbon sequestration. This aspect is very important for extensive livestock systems (either organic or not), especially for ruminant ones, since cattle grazing captures 20% of the CO_2 released into the atmosphere by deforestation and agriculture worldwide [58]. If carbon sequestration were included in the evaluations (as done by [25]), extensive farms and sensitive ecosystems would show better results in the evaluations of their environmental impact, which could lead to higher public support, competitiveness, and sustainability.

In relation to the organic beef cattle sector, [25] carried out a comparative assessment of the sustainability of organic and conventional beef cattle farms located in agroforestry systems and rangelands of southwestern Spain. It is worthy to mention that conventional farms where extensive, pasture-based, and low-input; and that all farms had cows, either with presence of a fattening period of the calves or just selling them at the weaning age. These two last productive orientations where selected as they are representative of the sector and the area under study. The results showed that organic farms had a higher overall sustainability, especially with regard to the environmental dimension. In this sense, the authors reported that the agroecosystem management (agricultural practices) and farm structures were slightly more environmentally friendly. For example, organic farms tend to implement more measures to reduce erosion and to improve soil fertility, also developing better dung management that avoided nitrogen fluxes and allowed farmers to elaborate compost. Only clear differences where found regarding the use of pesticides, herbicides, and/or mineral fertilizers. This is consistent with the findings of [59] in smaller organic beef cattle farms located in a more humid area (northwestern Spain).

Hence, the presence of an approach and configuration of the farms oriented to organic principles (namely, the environmental systems) found in the study of [25] was really scarce, since the improvement and/or maintenance of the ecosystem did not constitute an important driver nor a motivation of the farmers to run their organic adventure. A higher degree of farmer's engagement and awareness toward the sustainability of the agrifood sector is needed. Specifically, the implementation of such sustainable management practices of the agroecosystem, such as diversification (the integration of crops, livestock, and trees), are advisable for sustainable land use management [60, 61] and reduce their carbon footprint [57]. Also, these measures deserve to be taken into account by policy makers due to their positive agro-environmental and socio-economic externalities [24].

With regard to swine, Dourmad et al. (2014) evaluated the environmental impacts (per kg of pig live weight and per ha of land used) of 15 European pig farming systems, comparing them with their conventional counterparts, among other types of farming systems, from which "traditional" was an interesting classification worthy of being mentioned since they account for an important part of the livestock sector and rural economy of many areas. This system was defined as "using very fat, slow-growing traditional breeds and generally outdoor raising of fattening pigs". When looking at the results, one can observe that the main differences were found between the traditional systems and the rest of farms. Environmental impacts were, in general terms, lower for conventional farms, when they were measured by kg of pig produced. Conversely, when expressed per ha of land use, mean impacts were 10% to 60% lower for traditional and organic systems, depending on the impact category. These results are in line with those abovementioned, and as previously explained, they are mainly due to the higher land occupation per kg of product and the longer productive times.

Another important point that [62] mentioned was the effect of the autochthonous breed on the environmental impact of the farms. They stated that the use of traditional local breeds, with reduced productivity and feed efficiency, results in higher impacts per kg of live weight. [63] added that the effects of the use of autochthonous breeds have not been adequately demonstrated with regard to some topics (different than the preservation of the genetic heritage and traditional landscape—aesthetical values). Due to this, [24] and [63] highlighted the necessity to deeply study the interactions and effects of the different livestock systems, especially those with beef cattle, since the scientific literature in addressing this sector is scarce. In line with this argument, [64] mentioned that agricultural practices affect biodiversity in a higher degree than the breeds itself.

Due to these results, context, and the scientific literature available that addressed the topic, [25] came to the conclusion that the externalities of organic farms (when compared with the conventional ones), are highly dependent on their production system, their context (socioeconomic, environmental, political, and institutional), and their marketing strategies. These conclusions can also be found in other studies, such as the review of [23] about the organic sector as a whole and its relationship with rural development.

Therefore, the future strategy of research and innovation in organic farming must prioritize productivity gains that address the farms as a whole, while paying major attention to secure the positive ecological performance organic agriculture can provide, since the environmental benefits it provides are absolute goods and cannot be relativized by the fact that yields are currently lower than in conventional agriculture. Moreover, there is a high potential for reducing the yield gap between organic and conventional farms through agricultural research [47].

4. Factors influencing organic livestock farms' success

4.1. Regulation and certification bodies

With regard to the legislative side, it is very important to note that regulations on organic production embrace a wide variety of organic farms; they allow using different animal breeds, structures, agro-ecosystem managements, feeding strategies, and marketing strategies. As a consequence, organic the livestock farm's success and perspectives are really different from one place to another. For example, [65] found that the situation in North Germany was in contrast to the region in the south, where the variability of amount and proportion of the different feed types is predominantly independent of the milk yield. Many factors shape these differences, such as the ecosystems on which farms are based and consumers' demands and willingness to pay.

Additionally, the different criteria of the certification bodies (public and private) act in the same way, since they usually decide whether some exceptions to the regulations can be applied at the farm level. Due to this, it is important to unify criteria. Also, the cost of certification is not affordable for many farmers (especially small farmers, which play a great role in sustainability and food security). Fortunately, nowadays, many efforts are being made to both facilitate the market of organic products worldwide (i.e., agreements between the European and American (USDA) standards) and to reduce cost of certification (i.e., by means of Participatory Guarantee Systems).

Moreover, organic regulations and private standards do not cover marketing aspects (key in the social, economic, and environmental sustainability), so that it is difficult to evaluate to contribution of the organic livestock sector to the sustainability of the food system.

4.2. Implementation of organic farms: Its consequences on the farms' economic and productive performance

Some studies have assessed the consequences of converting livestock farms to the organic system. Their feasibility and success depend upon the structure and context of the previous (conventional) farm. To cite an example, ruminants pasture-based farms such as those located in southwestern Europe and in the Mediterranean basin (especially those oriented to meat production) may be easily converted into organic ones since conventional and organic farms are quite similar [66-67]. On the contrary, species that are mainly reared under intensive production systems will have to go through a difficult process of conversion, e.g., poultry, swine, and dairy cows. And in parallel depending on the farmers´ motivations for converting, the situation of the farms, and their perspectives vary.

As monogastric production systems are not so linked to land as ruminants ones are, and due to the higher prices of organic feedstuffs, it is far more difficult for farmers to convert to produce under the organic system. In this sense, swine rearing under free range production systems (such as those of the dehesa ecosystem in southwestern Spain) appears to be the system that could be converted to the organic model successfully. However, the weaning period seems to be the bottleneck of this sector, because many veterinary interventions are usually needed.

Moving from species to farms structure, it is interesting to note that mixed livestock production systems are those with a higher resilience (also economically), which would allow an easier transition to the organic system [25]. Accordingly, [68] claimed that co-grazing sows with heifers can diminish the parasite burden of the heifers, and that the pig inclination for rooting can be managed in a way that makes ploughing and other heavy land cultivation more or less superfluous. With regard to poultry, there is an indication that quite big flocks can be managed efficiently in a way where the flock act as weeders in other crops or fight pests in orchards. This integration of feed resources of the farms with the different livestock species is possible due to their different grazing habits [69, 70], and is pivotal for the sustainability of the agro-ecosystems and rural areas [25].

However, the consequences of the conversion process and externalities of organic farms may be very changing, since they depend on many factors [66, 23, 25, 35], such as the socioeconomic and environmental context of exploitation, the climate and topography of the land, the production system under study, the species reared, the regulations on course, the influence of private standards of certification, the availability of organic inputs and prices thereof, the development of the organic industry and marketing channels, and the consumer's behavior (demand and willingness to pay). In order to deal with these uncertainties, researchers have conducted studies that have evaluated the ease of conversion of different conventional farming systems to the former one: for dairy goats [71] and dairy cattle [72]. Therefore, before making conclusions about the adequacy of organic livestock farming, one must establish the limits of the study (local or global scale), its objectives, and motivations. Later, a multidisciplinary assessment of farm sustainability, a SWOT analysis, and an assessment of the feasibility of success along with a study of farms competitiveness must be carried out, as proposed by [67, 73].

In relation to organic beef cattle farms, although there is controversy, studies mainly show that organic farms have worse economic results than their conventional counterpart when they are studied by farm and year since they used to have longer production cycles when the farms are under the Common Agricultural Policy's (CAP) conditions [25, 59] or not [74]. They are also more dependent on both subsidies and premium prices. Finally, higher production costs (mainly derived from feeding and during the conversion period) have also been observed [25, 59, 74-75].

[54] analyzed the productive, environmental and economic impacts of the conversion process of conventional suckler cattle farms. They reported that the ban on chemical fertilizers led to a drop in farm area productivity and meat production (by 18% to 37% for the latter) and farm income (more than 20%). These drops were not compensated by the increase in the meat selling price (+5% to +10%). However, the use of inputs was reduced (by -9% to -52%), which is really important for the sustainability of pasture-based/low-input ruminant farms.

With regard to milk production, [76] found that organic systems had greater milk production. However, it seems that milk production per animal [77] and agricultural area [40, 78-79] is lower in organic farms.

Although at first glance, this lower milk production seems negative, this could have very positive implications and advantages. Firstly, cows could have a longer productive life (longevity), which in turn could make animals produce more liters in their entire life, thus reducing the environmental and economic impact of rearing heifers. Secondly, the increase of the productive capacity of the cows has been followed by health problems such as increased somatic cell counts and mastitis, as well as reduced fertility rates and tolerance to heat stress, which could be reduced if cows reduce their production level. Moreover, such reduction would help to reduce the amount and/or proportion of non-structural carbohydrates given to the animals, which would reduce the risk of acidosis, lameness, and other secondary disorders. In this sense, [76] observed that cattle on conventional farms were fed approximately twice as much grain as cattle on organic farms. All these advantages match part of the goals set in the Strategic Research and Innovation Agenda for Organic Food and Farming set by the European Technology Platform (TP Organics) [80]: improved health, robustness, and longevity.

Moreover, as the price of organic milk seems to be more stable [81], the consumption of mothers' milk by calves may be a profitable strategy in farms where milk is not the main marketable product. Thus, [82] found that the consumption of mothers' milk by calves resulted in high weaning weights at 3 months of age, and Keifer et al. (2014) found that organic dairy cows farms performed economically better than the pasture-based conventional farms analyzed.

Not all is about ruminants. Other sectors, such as rabbits, have also been studied. Thus, [83] showed that the effects on zootechnical parameters are due to the production system and genetics. They found that hybrid rabbits reared under conventional housing had the highest average daily gain, and local grey and organic, the lowest.

4.3. Public subsidies: The Common Agricultural Policy (CAP) in the European Union

Despite the abovementioned low productivity in organic farms, their higher environmental externalities should drive a higher support by the rural development measures of the EU's CAP [24, 84-85], since they play a greater role in the conservation of traditional landscapes and ecosystems by means of a “greener” agro-environmental management, which is finally of great importance for the sustainable development of the surrounding rural areas, where the agricultural sector remains an essential driver of the rural development of this area [27]. In this sense, [84] have claimed the necessity to recognize in a higher degree the role of the extensive livestock systems on environmental and cultural heritage preservation.

4.4. Animal nutrition: Legislation and market

Animal nutrition constitutes an important pillar of organic livestock production. Thus, [86] found that feeding strategies among Wisconsin organic dairy farms were major determinants of herd milk production and income over feed costs. These findings may serve current organic and transition farmers when considering feeding management changes needed to meet organic pasture rule requirements or dealing with dietary supplementation challenges.

In relation to organic feedstuffs, the most important obstacles are the difficulty to find them and their prices. This situation is aggravated by the farms’ high external dependence of feedstuff due to decoupling between crops and livestock. These facts reduce the organic livestock farms´ adaptability, and their access to feed additives and materials of high quality. As a result, the organic livestock sector face a big challenge that, along with other factors, has lead to a situation characterized by organic livestock farms without organic products, which reduces their profitability and future perspectives of success. This has been observed either in beef cattle [25], dairy cows farms [87], or other species [88].

One possible solution for overcoming this barrier would be the use of local agricultural by-products for animal nutrition since their price is usually low, and according to [89], they allow to add to their economic value, while providing an environmentally sound method for disposal of the by-product materials. Also, it would lead to either an increase in the incomes for the organic business that sell such by-products or a reduction in the expenditure related to their disposal.

European regulations limited the use of many feed additives, such as mineral preparations, with the aim that organic livestock farms rely on soil minerals. However, their levels can be low in some areas, which can lead to some mineral deficiencies, as observed by [90] in organic calves. This limitation is especially important in the case of dairy cattle, since nutritional requirements of cows are really high. Due to this, researchers are looking for new feedstuffs that are both allowed and useful for the organic livestock sector, such as minerals sources (seaweed in [91]), different pastures (birdsfoot trefoil by [92]), and fat supplements [93].

As the ration for organic herds has been required to be 100% organic by the European regulations, [94] investigated the possible effects of 100% organic feed on the energy balance in Swedish organic dairy herds as indicated by blood parameters, and concluded that the legislative restrictions "did not appear to have had any detrimental effects on the metabolic profiles of organic cows in early lactation and there was no evidence that organic cows were metabolically more challenged or had a severe negative energy balance".

However, the feed resources of the own farm are usually scarce and/or of poor quality in many areas. Thus, [46] pointed out that the availability of the forages in semi-arid areas, such as the Mediterranean basin, is seasonal, and that its quality is not always optimal. Due to this, the supplementation of the animals is frequently needed. Nevertheless, their availability is low, because for the feed industry it is really costly to turn organic or to create an organic line of products, as they must separate the conventional and the organic lines of productions, and the profitability of this investment is very questionable. Moreover, the bureaucracy would increase the workload of the companies, thus reducing their agility and profitability. In this sense, more concrete instructions for the inclusion of feed additives should be introduced in the regulations.

A correct nutritional management is the basis for an optimal health status and, as a consequence, adequate levels of productivity. Furthermore, this productivity has been identified as key to reduce the GHG emissions from livestock. Due to this, policy makers should seriously address this topic since many conventional companies of the feed sector have a really good portfolio of feed additives that are not susceptible for having not-allowed products (such as GMO or residues of antibiotics), and could improve rumen fermentation (thus reducing the enteric methane emissions), reduce the use of antibiotics (reducing the environmental pollution and public health issues related to them), which would increase the efficiency of the livestock sector, and finally, the competitiveness and sustainability of it. Good examples of additives would be limiting amino acids (such as methionine in dairy cows), chelated (also called "organic") minerals, salts of organic acids, yeasts, essential oils, and fat supplements, among a large list of them. Specifically, organic minerals allow a correct nutritional management, reduce the exploitation of resources, and reduce environmental pollution.

4.5. Animal health, welfare, and technical management

As a consequence of the growth in the number of organic farms worldwide, many veterinarians are encountering this method of production. However, they normally suffer from lack of knowledge with regard to the management of animal health suitable to this type of production, such that it "sustains and enhance the health of soil, plant, animal, human and planet as one and indivisible" (according to IFOAM). The focus is to achieve and maintain high herd health and welfare status with low usage of veterinary medicines [95]. The EC regulations for organic farming [28] state that organic livestock should be treated preferably with phytotherapeutic products. However, almost no phytotherapeutic product is registered for livestock, and information regarding veterinary phytotherapy is really scarce [96].

As health and welfare of organic livestock are highly interrelated, veterinarians not only must avoid livestock illness, but also maintain the animals´ physical, mental, social, and ecological well-being [97]. However, the combination of "natural behavior/living" with optimal health and welfare status is not easy, as [98] and [99] interestingly stated, extensive production systems (e.g., free range production) expose livestock to increased disease challenge, and "a healthy system does not automatically mean good welfare for the individual". However, outdoor housing also has benefits [100]; outdoor housing with functional wallows and access to grass and roots or outdoor runs and roughage can enhance pig welfare and reduce pen-mate-directed oral activity and aggression, which is a really important issue in piglet production.

[99] came to the conclusion that animal health is as good or better than in conventional farming, with the exception of parasitic diseases, and that organic farming systems have a "welfare potential", but organic farmers must deal with the dilemmas and take animal welfare issues seriously. [101] explores how the special organic conceptions of animal welfare are related to the overall principles of organic agriculture. They identified potential routes for future development of organic livestock systems in different contexts (northwestern Europe and tropical low-income countries). Moreover, as outdoor-reared animals make more use of the farm’s feed resources, negative consequences can also be found with regard to food safety. Thus, it has been demonstrated that a significant number of organic eggs had dioxin contents that exceeded the EU standard [102].

When one analyzes the health and welfare status of different livestock species, one rapidly realizes that the control of intestinal parasites and to achieve adequate nutritional management are the main bottlenecks and challenges.

Regarding ruminants, [103] also identified these two issues as challenging after studying organic goats. Later, [77] observed lower calf mortality, less incidence of mastitis, fewer rates of spontaneous abortions, and reduced ectoparasite loads in organic farms. However, internal parasite control was again detected as a weak point (greater prevalence was observed in organic farms). Fortunately, animals in the organic system exhibited lower parasitic resistance to anthelmintics, which gives hope to improve herd health status by means of future strategies. [104] reviewed the prevalence of zoonotic or potentially zoonotic bacteria, antimicrobial resistance, and somatic cell counts in organic dairy production; and they found contradictory results in relation with in bacterial outcomes and Somatic Cell Count (SCC) between conventional and organic farms.

Later, [105] discussed the effects of weaning calves at an older age on welfare and milk production. They claimed that foster cow systems with additional milking might be a promising alternative since calves can satisfy their sucking motivation and have social contact to mothers/adult cows; and additionally, weaning stress might be reduced and milking the cows when suckling calves could lead to an increased total milk production. However, this system has economical consequences that must be assessed carefully. Due to this, the authors concluded that further research is needed to reconcile consumers' demands and the possibilities of farmers using such systems.

With regard to animal welfare, [106] assessed the welfare state of dairy cows in European farm systems (extensive and/or low-input farms compared with organic ones) using the Welfare Quality® assessment protocol. Farms had mainly an acceptable and enhanced overall welfare state, although specific problems were found (injuries and discomfort of the lying areas, mutilations, poor human-animal relationship, or insufficient water provision). [107] indicated that most of the organic and conventional farms would have been unlikely to achieve many criteria of audit and assessment programs currently used in the U.S. dairy industry. The parameters recorded were the following: neonatal care, dehorning, pain relief, calf nutrition, weaning, age at weaning, pain relief after and during dehorning, size of the calving area, body condition score, animal hygiene scores, hock lesions, and use of veterinarians. [108] explored how calf welfare is approached in six different organic dairy farms and how far the concept of naturalness is implemented. They observed differing understandings of "naturalness" and welfare, which lead to such diversity of organic farms in aspects that should be shared. In this sense, [82] found that some farmers had difficulties accepting negative implications of suckling systems such as stress after weaning.

The reliance of veterinary drugs is a hot topic that globally is trying to be reduced. In organic farms, where limitations in the use of veterinary drugs are higher, health-related problems can occur, thus undermining the farm’s profitability. To reduce these situations, [94], through the CORE Organic ANIPLAN, carried out a study with organic dairy farms of seven European countries, aiming at minimizing medicine use through animal health and welfare planning. Overall, after the implementation of the plan, there was a reduction in the total treatment incidence, and an improvement of the udder health situation across all farms. Hence, these authors concluded that the plan applied "can be regarded as a feasible approach to minimizing medicine use without the impairment of production and herd health under several organic dairy farming conditions in Europe".

Regarding beef cattle, [24, 59] found less use of veterinary medicines. These results are in line with those of [76], who found that the use of outside support and vaccinations were found to be less prevalent on organic dairy farms than on conventional farms. These last authors found little difference in the average reported somatic cell count and standard plate count.

In relation with monogastrics, parasites also constitute a concern. Due to this, the topic was also addressed under the framework of the COREPIG project, a pan-European project on organic pig production focused on the "Prevention of selected diseases and parasites in organic pig herds". One of the results of this project has been the publication of review papers that have provided really valuable information and reflections on the current status and challenges of the swine sector. [109, 110] reported that sows are kept in a variety of different production systems, "with some countries having totally outdoor management at pasture, some keeping animals indoors with concrete outside runs, and others having combinations of these systems". Although reports suggest that relatively few health and welfare problems are seen, the problem of parasites is also a concern within this sector (they are more prevalent in the organic sector). According to the arguments above exposed by [98] and [99], the authors discussed that organic sows had more behavioral freedom, but may be exposed to greater climatic challenges, parasite infestation, and risk of body condition loss. So that, again, the combination of welfare, health, and productivity poses an issue. Even, public health could be compromised, [110] highlighted the high exposure to *T. gondii* in organic pig farms in Italy, indicating a potential risk for meat consumption.

[111] also studied the health and welfare of suckling and weaned piglets in six EU countries. For this purpose, these authors used animal-based parameters from the Welfare Quality® protocol, and showed the main issues prevailing in these farms. [112] studied issues related to weaning in piglets, and they concluded that diseases around weaning are multifactorial so that "in order to solve problems around weaning, the complexity and the individuality of farm systems need to be taken into account".

Furthermore, it has also been reported that some disorders in pigs are less frequent under the organic system, namely, respiratory problems, skin lesions (including abscesses and hernias) and tail wounds. However, joint lesions, white spot livers, and parasitic infections were more common among organic pigs [100]. Due to this, although organic herds consumed three times less antibiotics than conventional ones, the reduction of anthelmintics seems to be more complicated. However, these researchers did not find any difference in mortality rate nor if more pigs in need of treatment in the organic herds.

Fortunately, it seems that some strategies to control the parasites in organic production are coming to scene. Thus, [100] recommended to rotate outdoor areas with as long interval as possible, i.e., by including the pigs in the crop rotation. Furthermore, they stated that an increase in the number of specialized organic farms will help carry out other management strategies needed to maintain the good health of the pigs: implementation of age-segregated production and buying piglets from only one or few units.

Finally, the aquaculture growing sector has also been assessed from the organic side. [113], after studying the open aquaculture systems, reported that both organic and conventional systems present unresolved and significant challenges with regard to the welfare and to environmental integrity, due to many issues such as water quality, escapes, parasites, predator control, and feed-source sustainability. Finally, they concluded that under the current situation, open net-pen aquaculture production cannot be compatible with the principles inherent to organic farming.

4.6. Marketing of organic products and consumer's behavior

Organic livestock farms (when pasture-based and low-input) are perceived as socially more acceptable than intensive ones because they provide many environmental services, such as reducing the risk of fire, improving soil fertility and pastures quality, as well as biodiversity and carbon sequestration. Moreover, they have lower environmental impact linked to land use change (deforestation) and to the use of energy (extraction, manufacturing feedstuff, transportation, etc.) [19-22]. Furthermore, they do not compete with humans for food, which could be another argument to buy organic as the concern about food security has become mainstream. Note that around 70% of the grains used by developed countries are fed to animals and that livestock consume an estimated one-third or more of the world's cereal grain, with 40% of such feed going to ruminants, mainly cattle [114].

However, out of the farm gate, the lack of development of the marketing channels and industry, low consumers awareness of organic products, and their low willingness to pay a premium price for them hinder the demand for organic animal products. As a consequence, most of the farmers are not able to sell their products to the organic market and at a price that allow them to cover their production costs; one can easily find many organic farms without organic products [25, 88]. In the case of livestock, this situation is due to: (i) the difficulty to find organic feedstuff and its cost and (ii) low consumer demand linked to low level of knowledge, awareness, and willingness to pay premium prices. Specifically, in the beef sector, the demand for organic weaned calves (not fattened) was almost non-existent, which make it very difficult to carry out the market of organic beef [25].

In the few cases in which producers can manage to sell their products as organic, such scarcity of developed channels causes the price differential between organic and conventional products to be still high, feeding a loop characterized by reduced per capita consumption and low presence of organic products in the supermarkets [115-116]. As a consequence, demand and willingness to pay consumers for organic products is reduced [117], especially in relation to beef and in countries such as Spain [118-119], despite being one of the first producers in Europe. In order to reduce the cited price differential and increase consumption, a wider distribution of these products is key.

In the case of beef, this little demand is partly due to the fact that consumers do not perceive clearly the differences between organic and conventional meat [115]. Therefore, [120] showed that there is a clear need to excel in organic meat products, quality, and environmental contribution. However, it is can be complex to define and evaluate the quality characteristics of a meat product, especially when the benefits of organic meat over conventional are not clear from the sensory, nutritional, and health aspects[115], particularly when they are compared with conventional extensive systems, such as those present in the pasture.

In summary, it is necessary to note that the demand for organic meat could stagnate due to the following reasons: price differential with conventional meat, inelasticity of demand for this product, and limited knowledge and awareness about the product by consumers. Fortunately, there are strategies that could solve this weak domestic demand, such as exporting. However, meat export is not a strategy easy to carry out due to the cost of transportation and storage, the bureaucracy, and the needed know-how.

Moreover, the approach should not be to just find the markets for organic products, but other additional strategies must be studied. Firstly, it must be taken into account that there is a change in consumer preferences towards local [121-123] and more sustainable [122, 124] products. Moreover, the level of knowledge and awareness about organic products is really low in some countries and regions in Europe [119], leading to the fact that consumers find it hard to differentiate between organic, local, traditional, and sustainable [122, 125-127]. Additionally, one cannot assume that all consumers believe that all organic products are totally complying with the organic principles (many consumers may have not even heard about such principles) and that the organic principles match with the internal triggers and values of the consumers.

To overcome this diversity in the market, organic products should try to be linked to other quality standards. The products with more added value (they would be more than organic) and the growing consumer preferences towards them have both been called 'organic-plus', and have been described by some authors [124]. Within this trend, environmental sustainability, freshness, and local economy are attributes of relevance. In other words, the consequences of the agrifood system (marketing channels, distribution) are becoming important for a growing number of consumers. However, these topics are not covered by the organic regulations, and most of the organic products have been produced and marketed through the mainstream agrifood system; conventional marketing channels characterized by the concentration of production, exporting most of the production, low domestic consumption, and concentration in supply centers and large retail chains. This orientation of organic production into conventional marketing channels and production systems (monocultures and agrochemicals) has been well-documented and is known as "conventionalization" of the organic production and "input substitution" [128].

As a consequence, this type of production (despite being organic) does not always provide consumers with products as fresh, local, and sustainable as they desire, nor positively impact environmental protection and/or rural development in such degree, as was explained above.

In summary, it seems that organic products are not the solution for many consumers that really want to access sustainable products. If organic companies and/or policy makers do not take into account these aspects, the growth of the organic sector, as well as their positive externalities, will be limited.

5. Conclusions

Organic livestock farming (especially its organic principles than regulations) may be a useful strategy to overcome the challenges of the agricultural sector (sustainability, food security, and food safety) while matching with consumers´ tendencies (animal welfare, health, environmental protection, etc.). Furthermore, organic livestock farming could be also an interesting strategy for the eternal rural development issue and the farms' decreasing profitability.

However, the combination of complying with organic regulations and objectives and principles of organic farming while increasing overall sustainability is not an easy task. Due to this, it is inappropriate to generalize the benefits of organic livestock farming itself, since the feasibility of implementing organic livestock production systems and their consequences varies greatly, and are site and time-specific. Therefore, it must be remembered that any production system that does not evolve from its initial state (i.e., defined by law) and do not take into account both the time and spatial scales cannot be sustainable worldwide and for a long time. Due to this, a SWOT study along with an assessment of the future effects and difficulties of organic farms under specific contexts is really needed. By doing so, it will be possible to design site-specific and successful options that comply with organic regulations and principles, while being sustainable.

Moreover, some topics must be addressed in order to increase the organic livestock farm's success. Firstly, it has been observed that most of the farmers do not focus on sustainability nor environmental improvement, and that many farms are easily complying with the organic regulations without carrying out environmentally-friendly management practices in their agro-ecosystems. Due to this, improved education and training of farmers and consultants regarding conservation agriculture and GHG mitigation are really needed.

Secondly, there is a need to design feeding strategies that provide adequate nutrition, especially in areas with environmental constraints, such as arid and semi-arid areas. Moreover, regulations should both unify criteria and facilitate the production of feed additives by companies, because the consequences of it could be really important and positive for the organic livestock sector and for the sustainability of the food system.

Thirdly, the knowledge of the veterinarians with regard to animal health management must be improved as fast as the sector is growing. Related to this, more light must be shed on the relationship between animal welfare, "natural living-behavior", and animal health. Furthermore, health care protocols must be developed for each species, including research on alternative and complementary methods of disease prevention.

Fourthly, CAP schemes should be improved in order to reward systems that produce positive externalities in a greater extent despite being low in productivity, since the agricultural sector remains an essential driver of rural areas. These systems contribute to environmental, cultural, and heritage conservation, which finally lead to revitalized rural areas and overall sustainability (from the economic, social, and environmental standpoints).

Finally, and more urgently, special attention must be paid on the marketing strategies of organic products (organic plus products and marketing channels) since this is the main constraint of the sector, and it is the point where there are more possibilities for improvement for both farm profitability and overall sustainability of the food system.

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